

## **Semi-Annual Report of Functional Analysis department for 2022**

The staff of “Functional Analysis” department consists of 19 employees including 17 research associates. 8 of them doctor of sciences, professor.

- 1.Aslanov Hamidulla I. doct. ph.m.s.,prof.
- 2.Mammed Bayramoglu. doct. ph.m.s.,prof.sen.r.a.
- 3.Mirzoyev Sabir S. doct. ph.m.s.,prof.sen.r.a.
- 4.Huseynov Hidayet M. doct. ph.m.s.,prof.sen.r.a.
- 5.Gurbanov Veli M. doct. ph.m.s.,prof.sen.r.a.
- 6.Nabiyev Ibrahim M. doct. ph.m.s.,prof.sen.r.a.
- 7.Aliyev Araz R. doct. ph.m.s.,prof.sen.r.a.
- 8.Eyvazov Elsad H. doct. ph.m.s.,ass.prof. sen.r.a.
- 9.Aslanova Nigar M. doct. ph.m.s.,ass.prof. sen.r.a.
- 10.Mukhtarov Fekhreiddin Sh. c.ph.m.s.,lead.r.a.
- 11.Jabrailova Afet N. c.ph.m.s.,lead.r.a.
- 12.Latifova Aygun R. phd in math.,chief.r.a.
- 13.Guliyev Namiq I. c.ph.m.s.,r.a.
- 14.Vahabov Nazim G. chief.r.a.
- 15.Alimardanova Kamilla A. c.ph.m.s.,chief. r.a.
- 16.Osmanli Jalala A. phd in math.,chief. r.a.
- 17.Safarova Aynur N. phd in math.,chief. r.a.
- 18.Iskenderli Guller Z.sen.lab.ass.
- 19.Bayramova Aygun F.sen.lab.ass.

### **I. Scientific part.**

In the first half-year of 2022, in the department, according to the affirmed plan 17 scientific works are carried out on “Spectral analysis of differential operators”.

**Theme “Spectral analysis of differential operators”.**

**1).work: “Occurrence of the resolvent of a clan of higher order operator-differential equations in the  $\sigma_p$  classes.” Ex. doct.ph.m.s., prof. H.I.Aslanov.**

In this paper, conditions for the discreteness of the spectrum of the operator L are shown and the main equality connecting the eigenvalues, eigenfunctions, and Green's function of the operator is proved. It is proved that the operator is a Hilbert-Schmidt operator.

1.H.İ.Aslanov, R.F.Hatamova. On the existence and uniqueness of generalized solutions of second order partial operator-differential equations. Azerbaijan Journal of Mathematics ,v.12, №1, yanuary 2022, p.68-79.

2. H.İ.Aslanov, R.F.Hatamova. On the Neuman problem for a second order elliptic partial operator-differential equation in Hilbert space /Transactions of NASA , ser.Phys.Tech.Math.Sci., 42(1),2022, p.1-11.

3. H.İ.Aslanov, R.F.Hatamova.On well-deffined solvability of the Dirichlet problem for a second order elliptic partial operator-differential equation in Hilbert space.Proceeding of the Institute of Mathematics and Mechanics, National Academy of Sciences of Azerbaijan ,volume 48, Number1,2022,p.63-76.

## Theses

1.Г.И.Асланов, Р.Ф.Гатамова. О задаче Неймона для эллиптического операторно-дифференциального уравнения с частными производными второго порядка в гильбертовом пространстве. Актуальные проблемы математики и информационных технологий. Материалы III Всероссийской конференции с международным участием. (г.Махачкала издательство ДГУ, 7-9 февраля 2022), с.39-41.

2.Г.И.Асланов,Г.М.Эйвазлы.The asimptotic formula for the sum of the fourth deqrees of the neqative eigenvalues of the second order differential operator in the semi-axis.(online)Internatiol Simposium on Applied Mathematics and Engineering ISAME 22 Yanuary 21-23, 2022,Istanbul-Turkey .Abstract Book, p.128

**2).work: "Inverse problem of half-axis scattering for a system of Dirac equations with shear coefficients" Ex: doct.ph.m.s.,prof. sen.re.a. H.M.Huseynov.**

In the reporting semester, scientific research on the topic was continued, the solution of the basic equation was shown, and the algorithm for potential conservation was given.

## Theses

1.Hüseynov H.M., Şamilova R.Ə. "Yarımoxda kəsilən əmsallı ikinci tərtib diferensial tənlik üçün tərs məsələnin həlli alqoritmi" . " Tətbiqi riyaziyyatın müasir problemləri" (BDU) Respublika elmi konfransının materialları, Bakı, 2022 (17 may), s. 124-125.

2. Hüseynov H.M., Bağırzadə T.S. "Kəsilmə şərtinə malik Şturm-Liuvill tənliyi üçün səpilmənin tərs məsələsi" / " Tətbiqi riyaziyyatın müasir problemləri" (BDU) Respublika elmi konfransının materialları, Bakı, 2022 (17 may), s. 122-123

**3) .work: "Effect of the summation rate of the function on the rate of co-accumulation of the spectral separation corresponding to the one-dimensional Schrödinger operator." Ex:doct.ph.m.s., prof. sen.re.a.**

**V.M.Kurbanov .**

Bu yarımildə adi diferensial operatorların spektral ayrılışlarının yığılması araşdırılıb. İki tezis çap olunub, iki məqalə isə çapa təqdim edilib.

## Articles (submitted to print)

1. Vali M. Kurbanov, Khadija R. Godjaeva, Rahim I.Shahbazov. On absolute and uniform convergence of a biorthogonal series in root functions of an odd order differential operator. // Transactions of NAS of Azerbaijan (çapa təqdim olunub).

2. Vali M. Kurbanov, Aytəkin I. İsmailova. On convergence of spectral expansion in eigen-functions of dirac operator // Proceedings of the Institute of Mathematics and Mechanics, National Academy of Sciences of Azerbaijan (çapa təqdim olunub).

## Theses

1. Курбанов В.М., Гаджиева Г.Р. Теорема о покомпонентной равномерной равносходимости для оператора типа Ди рака 2m-го порядка //

СОВРЕМЕННЫЕ МЕТОДЫ ТЕОРИИ КРАЕВЫХ ЗАДАЧ . Материалы Международной конференции Воронежская весенняя математическая школа ПОНТЯГИНСКИЕ ЧТЕНИЯ—XXXIII Посвящается Юрию Ивановичу Сапронову (75-летию со дня рождения) (3–9 мая 2022 г.) стр. 65-67.

2. Курбанов В.М. О скорости равномерной равносходимости спектрального разложения функции из класса  $f(x) \in W_1^p(G)$ ,  $p > 1$ , по собственным функциям дифференциального оператора четного порядка с тригонометрическим рядом // СОВРЕМЕННЫЕ МЕТОДЫ ТЕОРИИ КРАЕВЫХ ЗАДАЧ . Материалы Международной конференции Воронежская весенняя математическая школа ПОНТЯГИНСКИЕ ЧТЕНИЯ — XXXIII Посвящается Юрию Ивановичу Сапронову (75-летию со дня рождения) (3–9 мая 2022 г.) стр. 71-72.

**4).work: "Regular solution of the boundary value problem for a class of second-order operator-differential equations in Sobolev-type spaces."**

**Ex: doct.ph.m.s.,prof. sen.re.a. S.S.Mirzoyev.**

In the first half of the reporting year, scientific research on the topic was continued and the conditions for regular resolution of some class boundary issues were determined.

**5) .work: "Inverse problem for the non-self-adjoint Sturm-Liouville operator."Ex: doct.ph.m.s., prof. sen.re.a. I.M.Nabiyev.**

In the first half of 2022, 1 scientific article was published (WOS), and 1 was accepted for publication.

## Articles

I.M.Nabiev. Reconstruction of the differential operator with spectral parameter in the boundary condition // Mediterr. J. Math., 2022, v. 19, № 3, art. 124, p. 1-14 (Web of Science İmpakt faktor =1.4, Scopus).

<https://doi.org/10.1007/s00009-022-02053-y>

1. A.Q. Fərzullazadə, İ.M. Nəbiyev. Dirak operatorunun məxsusi ədədlərinin qarşılıqlı yerləşməsi // BDU Xəbərləri, fiz.-riyaz. ser., 2022, № 1. (çapa qəbul olunub).

**6) .work: "On smooth solutions of fourth order operator-differential equations with a class of recurring characteristic. "Ex: doct.ph.m.s., prof. sen.re.a. A.R.Aliyev.**

During the reporting half-year, scientific research on the subject was continued

## Article

1. Aliev A. R., Muradova N. L. Conditions for the existence of smooth solutions for a class of fourth order operator-differential equations // Baku Mathematical Journal, 2022, vol. 1, № 1, p.p. 3-14.

<https://www.bakumathj.org/archive/Vol1No1/j.bmj.001.pdf>

**7) .work: "Expansion and spectral issues for high-order operator-differential equations".Ex: doct.ph.m.s. prof. sen.re.a.M.Bayramoglu**

Self-adjoint expansions of a minimal operator defined by a class of higher-order operator differential expressions are studied in the paper.

**8)work: "Constructing the Schrödinger operator using the magnetic Laplacian in a three-dimensional layer and determining the number of eigenvalues of its critical spectrum to the left of the threshold."**

**Ex: doct.ph.m.s., ass.prof. sen.re.a. E.H.Eyvazov.**

During the half-yearly reporting period, the exact lower limit of the magnetic Rayleigh relation, which plays an important role in the theory of surface superconductivity in two-dimensional space, was found. In addition, the existence and uniqueness of the solution of the inhomogeneous boundary value problem for the two-centered Sturm-Liouville equation was studied.

## Article

1. E.H.Eyvazov . Correct proof of finding the exact lower bound of the Rayleigh magnetic value, Baku Mathematical Journal, Vol. 1 No. 1, 2022, pp. 3-11.

## Theses

1. E.H.Eyvazov. Решение граничной задачи для двуцентрового уравнения Штурма-Лиувилля, Современные методы теории краевых задач, Материалы Международной конференции Воронежская весенняя математическая школа

**9) .work: "Expansion and spectral problems for high-order operator-differential equations".Ex: doct.ph.m.s., ass.prof. sen.re.a. N.M.Aslanova.**

### **Articles submitted to print**

1. N.M.Aslanova. On selfadjoint extensions of symmetric operator with exit to larger space. TWMS journal of pure and applied mathematics.
2. N.M.Aslanova. On extensions and spectral problems for fourth order differential operator equation.

### **Theses submitted to print**

1. N.M.Aslanova. On maximal operator and selfadjoint extensions of operator generated by fourth order differential operator expression.
2. N.M.Aslanova. Asimptotics of eugenvalue dustribution of one class selfadjoint extensions of fourth order differential operator.

**10) .work: "On stability of bases from excited exponent systems in Orlich spaces".Ex: cand.ph.m.s., ass.prof. lead r.a.**

**A.R.Jabrailova**

Here, a sufficient condition ensuring the basicity of the excited exponential system in the Orlich space is defined. An analogue of the classic Levinson's theorem on the replacement of a finite number of elements of that system has been proved.

### **Articles**

1. A.Jabrailova, A. Shukurov. On frames that are iterates of a multiplication operator, Revista Colombiana de Matematicas, 2021, vol.55, num.2, p.139-147 (Web of Science )

2. Джабраилова А.Н., Джабарзаде Р.М. К спектральной теории операторных пучков. The scientific heritage, 2022, №86(2), p.30-33

### **Theses submitted to print**

1. A.Jabrailova, R.Dzhabarzadeh. To the spectral theory of multiparameter system of operators. akad.I.Ibrahimovun 110-illiyinə həsr olunmuş «Riyaz. və Mexanikanın müasir problemləri» adlı beynəlxalq konfrans, 2022

**11) work: "On some properties of eigenvalues and eigenfunctions of multi-interval Sturm-Liouville problems." Ex: cand.ph.m.s., ass prof. lead r.a. F.Sh.Mukhtarov.**

In the reporting half-year, an article was published in which scientific research on the topic was continued.

### **Article**

1. Hayati Olğar, Oktay S.Muxtarov, Fahreddin S.Muxtarov. The weak eigenfunctions of boundary-value problem with symmetric discontinuities. Published: 28 January 2022 by [Walter de Gruyter GmbH](#) in [Journal of Applied Analysis](#) (scopus) <https://doi.org/10.1515/jaa-2021-2079>

**12) .work: "Inverse problems for the Bessel operator with respect to two spectra." Ex: cand.ph.m.s., lead.r.a. N.J.Guliyev.**

During the reporting period, the necessary conditions for the spectra of the two boundary problems, which share the potential and the Bessel singularity, have been obtained. Also, during the reporting period, the final versions of all articles accepted for publication in the journal Works of RMI were prepared and placed on the journal's website.

**13) .work: "Straight and inverse scattering problems for a system of one-order hyperbolic equations. ." Ex:c.ph.m.s.,chief. r.a. K. A. Alimardanova**

During the reporting period, the semi-axial scattering problem was studied for a system of three hyperbolic equations in the case of an incident wave. In addition, the half-axis scattering problem was studied for the system of six hyperbolic equations in the case of three incoming waves. A thesis was published. A thesis was also submitted for publication.

### **Theses**

1. К.А.Алимарданова, Ф.Р.Башлинская. Задача рассеяния для системы трех гиперболических уравнений на полуоси в случае одной падающей волны/ Ümummilli Lider Heydər Əliyevin 99-cu ildönümünə həsr olunmuş "Riyaziyyat və mexanikanın aktual problemləri" adlı Respublika Elmi Konfransının materialları, Bakı, BDU, 11-13 may 2022-ci il, səh 30-31.

**14) .work: "Inverse spectral problems for increasing potential Schrödinger operators." Ex: phd in math., chief. r. a. A.R. Latifova**

Yost solutions for the summable complex periodic potential Schrödinger equation were found. Using transformation operators, the solution was constructed and estimates for the kernels were obtained.

### **Article**

1.H.M.Masmaliev., A.R.Latifova. "The Jost Solutions to the Schrodinger Equation with an Additional Complex Periodic Potential". Journal of Contemporary Applied Mathematics, v.12,№1,2022, July(ISSN 2222-5498), p.39-43. <http://journalcam.com/wp-content/uploads/2022/03/120105.pdf>

**15) .work: "Classes of quasi-normal and a class of unitary operators on Banach space. " Ex: sen. res. ass. N.G.Vahabov.**

Here, a new class of unitary operators in Banach spaces is defined and its properties are studied. Also, the properties of hermit operators in the sense of R. Jabbarzade are studied.

**16) .work: "The straight problem for the Sturm-Liouville operator in impedance form. " Ex: phd in math., chief. r. a. J. A. Osmanli**



In the reporting semester, the existence of the Yost solution was proven, its integral expression was given, and the properties of the kernel of the integral expression were studied. Scattering data were determined.

### **Theses**

1.J.A. Osmanly, A.R.Latifova "On the Iost representation of the Schrodinger equation with delta-shaped potential" / Modern Problems of Mathematics and Mechanics PROCEEDINGS of the International conference devoted to the 110-th anniversary of academician I.I. Ibrahimov, Baku, 2022, p. 168-169

**17) .work: "The half-axis inverse scattering problem for a system of one-order linear hyperbolic equations in the case of two incident waves."Ex: phd in math.,chief. r.a. A. N. Safarova**

In this work, the problem of straight and reverse scattering on the semi-axis for the system of one-order linear hyperbolic equations in the case of two incoming waves is studied. Here, two different problems are considered together. It is as if a scattering operator acting everywhere in the space of limited functions was determined. The factorization properties of this operator were studied with the help of transformation operators.

## **II. Scientific-social activity.**

The head of the department, **doct. ph.m.s.,prof.sen.r.a. H.M. Aslanov** is a participant of the Science foundation, of the grant project of state oil Company.

He was an official opponent of one doctor of sciences degree and one phil. doct. dissertations.

He supervises three doctoral students. One cand. for a degree has defended phil. doct. dissertation.

**Doct. ph.m.s.,prof.sen.r.a. A.R. Aliyev** is an editor-in-chief of the international scientific journal “Azerbaijan Journal of High performance computing” (Azerbaijan), manager editor of the international scientific journal “Azerbaijan journal of Mathematics” and a member of the journals: «Proceedings of the Institute Mathematics and Mechanics, National Academy of Sciences of Azerbaijan» (Azərbaycan), «Transactions of Azerbaijan Institutes of Technology» (Azərbaycan), “Electronic scientific journal, SCIENCE and TECHNOLOGIES: MATHEMATICAL MODELLING. COMPUTER SCIENCE“ (Rusiya) və «Mathematics and Statistics»

**Doct. ph.m.s.,prof.sen.r.a. I.M. Nəbiyev** has participated in the international conference. His 2 papers were published. They were published in Web of Science and Scopus base journal. He was a chairman of the State Certificate Commission (in mathematics) in Azerb. State Oil and Industry University.

**Doct. ph.m.s.,prof.sen.r.a. H.M. Hüseynov** is a member of editorial board of a lot of international and republican scientific journals. He is an adviser of magisters and doctoral students.

**Doct. ph.m.s.,prof.sen.r.a. S.S. Mirzoyev's** two cand. for degrees have submitted their dissertation works to the Scientific Council of IMM.

Many of the department collaborators are engaged in pedagogical activity in different higher education institutions of the Republic.

## **PARTICIPATION IN SCIENTIFIC SEMINARS**

All the collaborators have participated in the institute and department seminars.

## **PUBLISHED SCIENTIFIC PAPAERS**

**Heard of department:**

**d.ph.m.s.prof. H.İ.Aslanov**